MANUAL OF METHODS IN FISHERIES BIOLOGY

compiled by

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Fascicule 7

Section 2. Observations on the physical and chemical environment

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2.3.3 **Observations of sea surface**

Adequate observations of sea surface can be made simply, without instruments, provided consistency and accuracy of description are maintained. This can be effected by careful use of the appropriate meteorological and sea-surface codes.

2.3.3.1 Waves

Wind waves and swell should be observed and recorded separately. They are usually superimposed and a certain amount of practice is necessary to distinguish between them. The following notes will be found of assistance.

Sea (*wind waves*) — Waves caused by wind in the immediate neighborhood at the time of observation. The direction of the waves is usually the same as that of the wind, except when the wind changes direction quickly. The wind-wave period is usually smaller than that of the swell; also wind waves are steeper.

Swell — A system of waves created by winds at a distance from the point of observation. The period is long and the wave round.

The wave characteristics which should be used for reporting are:

Length — The horizontal distance between successive crests or troughs (equal to the wave period multiplied by the wave speed).

Period — The time between the passage of two successive wave crests past a fixed point (equal to the wave length divided by the wave speed).

Speed — The distance travelled by a wave in unit time (equal to the wave length divided by the wave period).

Height — The vertical distance between trough and crest.

The period, direction and height can easily be observed. Period can be determined by noting some small object or patch of foam on the surface, and with a stop watch, timing the interval between its appearance on the crest of one wave and its appearance on the crest of the next wave. Many observations should be made of the same object and the period recorded as the mean calculated by dividing the total time, measured with the stop watch, by the number of appearances of the object on the wave crests. The direction from which the waves come can be ascertained by adding or subtracting 90° to or from the compass bearing of the crests. To estimate the height of small waves the observer should be close to the sea surface and preferably amidships. To estimate the height of high waves the observer should climb up

and down the mast and record the height of his eye from sea level when he sees the crest of the wave relative to the horizon. The average height of the larger well-formed waves should be recorded. This is, of course, a very rough method.

When making simple wave observations from coastal stations care must be taken to choose a site from which shallowness and/or reflection does not give false impressions of the waves. For such observations special wave recorders are available, but need experts to install them and special instruction for interpretation of their records. A graduated line at the end of a pier or an anchored floating buoy will give reasonably accurate visual measures of both wave height and period. The codes for recording sea and swell are set out in Tables 1 and 2.

TABLE 1. - CODE FOR REPORTING SEA CONDITIONS

Code figure		Height	
		meters	feet (approx.)
0	Calm-glassy	0	0
1	Calm-rippled	0 - 0.1	0 - 1/3
2	Smooth-wavelets	0.1 - 0.5	1/3 - 1 2/3
3	Slight	0.5 - 1.25	1 2/3 - 4
4	Moderate	1.25 - 2.5	4 - 8
5	Rough	2.5 - 4	8 - 13
6	Very rough	4 - 6	13 - 20
7	High	6 - 9	20 - 30
8	Very high	9 - 14	30 - 45
9	Phenomenal	over 14	over 45

The following phenomena should also be observed and reported:

Breakers The collapse of a whole wave when it runs into very shallow water (about half the wave length).

TABLE 2. - SPECIFICATIONS FOR SWELL

LENGTH	Feet	Meters
Short	0 - 300	0 - 100
Average	300 - 600	100 - 200
Long	> 600	> 200
HEIGHT		
Low	0 - 7	0 - 2
Moderate	7 - 13	2 - 4
Heavy	> 13	> 4

Surf The broken water between the shoreline and the outermost line of the breakers.

Breaking sea The partial collapse of the crest of a wave, caused by:

(*a*) action of the wind;

(*b*) steepening of the wave when it meets a contrary current or tidal stream;

(*c*) steepening of the wave when it runs into shoal water not shallow enough to cause a breaker.

2.3.3.2 ICE

Sea ice can be recorded according to the code given in Tables 3 and 4. A revised ice code and classification with illustrations is being prepared by the World Meteorological Organization. The nature, amount and size of the ice should be recorded, using the special observation codes.

2.3.3.3 COLOR

By "color" of the sea is meant the color of the sea water and not that of light reflected from the surface, nor the reflection of the clouds and the sky. The color depends on the scattering of light by water molecules and by sus-

TABLE 3. - CODE FOR REPORTING THE STATE OF ICE

0	Ice-free
1	Loose ice or new ice
2	Fast ice (up to 15 cm)
3	Drift ice (floes up to 15 cm)
4	Pieces of ice pressed together (ice breccia), or tight drift ice (raffed ice)
5	Open water along the coast
6	Strong fast ice (> 15 cm thick)
7	Strong drift ice (> 15 cm thick)
8	Pack ice
9	Ice pressure
10	Unknown

TABLE 4. - ICE CODE FOR SHIPPING
(Baltic Code)

0	Free for all shipping
1	Free for steamers; difficult for sailing ships
2	Difficult for steamers; closed for sailing ships
3	Possible for powerful steamers
4	Possible only for steamers with ice protection
5	Possible with icebreakers
6	Open way in ice exists (made by icebreakers)
7	Shipping temporarily stopped
8	Shipping stopped
9	Shipping possibilities not known, (e.g., because of visibility)
10	No report

TABLE 5. - FOREL WATER COLOR SCALE CODE

Code	Description
00	Deep blue
10	Blue
20	Greenish-blue (or green blue)
30	Bluish-green (or blue green)
40	Green
50	Light green
60	Yellowish-green
70	Yellow green
80	Green yellow
90	Greenish-yellow
99	Yellow

pended matter in the water. The color of clear sea water is nearest to blue. Nature and size of suspended matter then cause variation from this. The greenish color in coastal waters, for example, depends largely on the amount of so-called "yellow substance" present. Color changes indicate different water masses and boundaries between them.

Color is usually estimated according to the Forel (or Osvald) color scales, or described exactly with the simple color adjectives. The Forel color scale is given in Table 5. The chemical methods used for measuring the color of fresh water (e.g., platinum-cobalt or methyl-orange standards) cannot be used in sea water. Several special kinds of optical apparatus can be used, but these require that the determination should be made immediately at the station where water samples are taken. References for these methods are given at the end of this Section.

Visual observations (underway or at the station) are made on the shadow side of the ship, in order to minimize the effect of sun glitter. The estimation of the color (in the Forel scale) at stations should be made against the white (Secchi) disk suspended in the water at a depth of 1 meter (see the de-

termination of transparency with the Secchi disk, Section 2.3.1.5. All discolorations of the water (e.g., phosphorescence) should be recorded, as should observations of drifting detritus and objects on the surface.

2.3.3.4 Tides, surges, water level

Continuous recording of tides is made by special tide gauges. Special observations are made at coastal stations by reading graduated water-level gauges on piers. The reference level of these gauges should be selected according to the standard practice in the country (e.g., mean low water, lowest low water, mean sea level, etc.). Information on tides is usually available in tide tables issued for certain specific areas or ports, and usually computed for a year ahead. The observers should make themselves familiar, from special publications, with the nature of the tides (i.e., diurnal, semidiurnal, range, etc.) in the area of interest.

2.3.4 Explanation of terms

Brackish water. Water with salinity lower than that of normal sea water (usually below $30^{o}/_{oo}$ S).

Chlorinity. Amount of chlorine and other halids in one kilogram of sea water, in grams.

Convergence. The meeting of ocean currents or two air masses.

Detritus. Any loose material; usually the remains of plants and animals after disintegration or wearing away.

Divergence. The opposite to convergence. Moving away from each other.

Drift ice. Numerous small pieces of floating ice of which the total area is less than that of the total water area in which the ice lies.

Extinction coefficient. The rate that light intensity decreases with distance in water.

Halogens. Group of chemical elements, comprising chlorine, bromine, iodine.

Hydrography. The science and practice of surveying oceans and seas. It excludes biological matter.

Hydrostatic pressure. Pressure exercised by the water column.

Messenger. A metal weight which is sent down on cables to manipulate suspended instruments.

Pack ice. Numbers of large pieces of floating ice that have come together and lie more or less in contact.

pH. Hydrogen ion concentration; a measure of the alkaline and/or acid property of the water.

Phosphate. A salt or ester of phosphoric acid, or a negative ion containing phosphorus and oxygen (PO_4). A very important nutrient salt in the sea.

Photocell. A cell or a vacuum tube whose electrical properties are modified by the action of light.

Refractometer. Any of various instruments used for measuring refraction.

SALINITY. The number indicating the amount of salts, in grams, in a kilogram of sea water when all the carbonate has been converted to oxide, the bromine and iodine replaced by chlorine, and all organic matter completely oxidized.

SIGMA-T. Density of water of given salinity and temperature at sea-surface pressure.

SPECIFIC VOLUME. Volume per unit mass *in situ*, reciprocal of density *in situ*.

TYNDALL EFFECT. Back scattering of light from minute particles suspended in the air or water.

TRACE ELEMENT. Elements occurring in natural waters and in organisms in minute quantities.

TURBIDITY. Cloudiness of a solution caused by suspended matter.

YELLOW SUBSTANCE. Brownish-colored organic compounds of unknown composition (related to humic acid) occurring in natural waters and derived from the decomposition of organic matter.

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